

Terrestrial Carbon Sequestration in the US Greenhouse Gas Inventory

Margaret Walsh¹ and Tom Wirth²

¹ ICF Consulting

² Non-CO₂ Gases and Sequestration Branch, US EPA

Overview



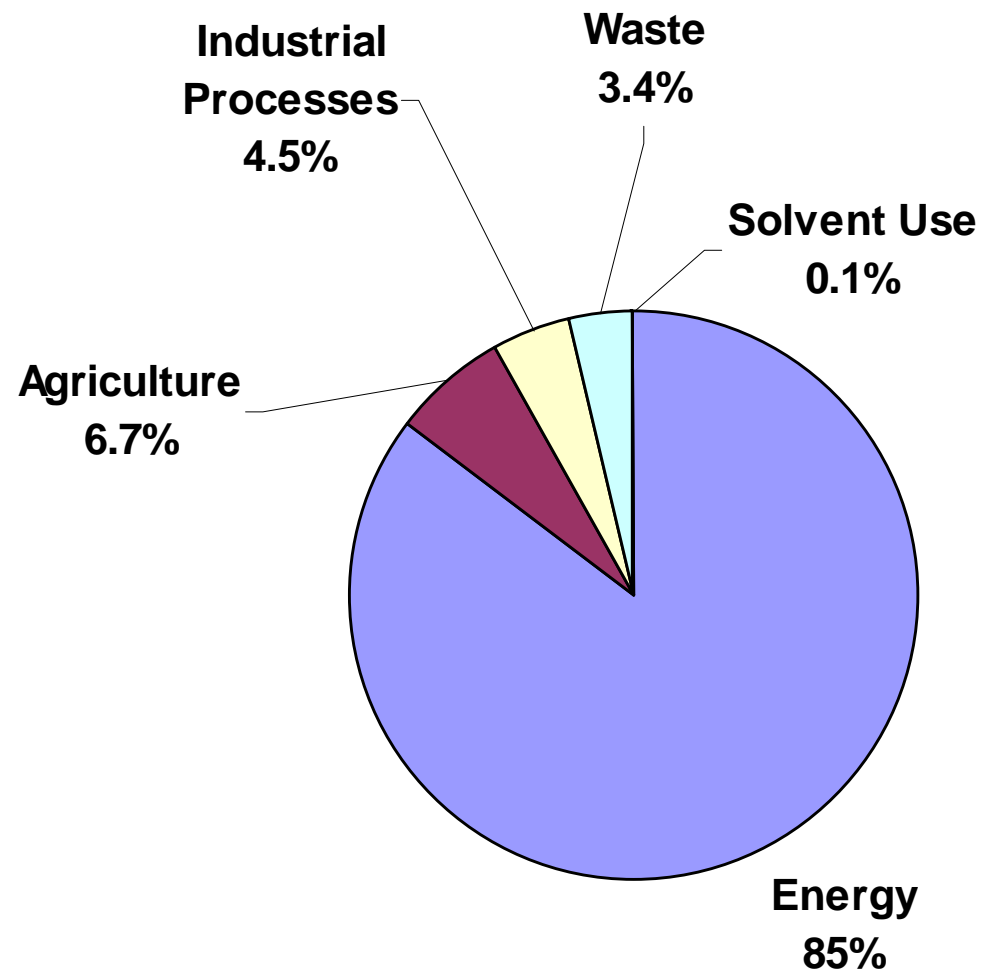
- The *US GHG Inventory*
- Land-Use Change and Forestry-Related Sequestration
 - Forestry
 - Standing Forests
 - Harvested Wood
 - Urban Trees
 - Agricultural Soil Carbon
 - Mineral Soils
 - Organic Soils
 - Soil Liming
 - Landfilled Yard Trimmings and Food Scraps

Inventory of U.S. Greenhouse Gas Emissions and Sinks



- Identifies and quantifies the US's primary anthropogenic GHG sources and sinks
- Commitment under the UN Framework Convention on Climate Change
- Published annually
- Undergoes extensive review process (internal, multi-agency, expert, public, international, UN)
- Available Online at:
<http://yosemite.epa.gov/oar/globalwarming.nsf/content/ResourceCenterPublicationsGHGEmissionsUSEmissionsInventory2004.html>

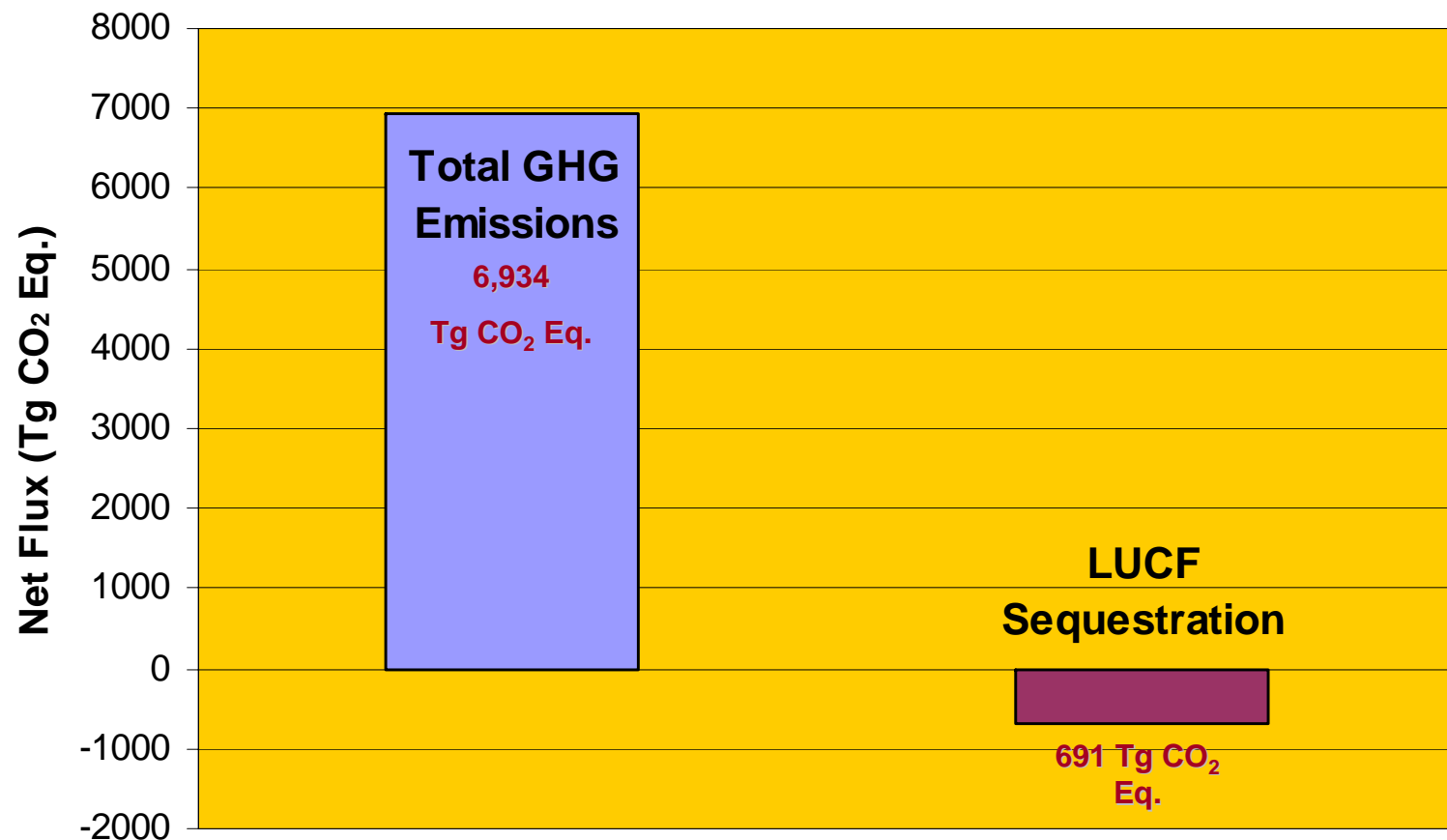
2002 US GHG Sectors



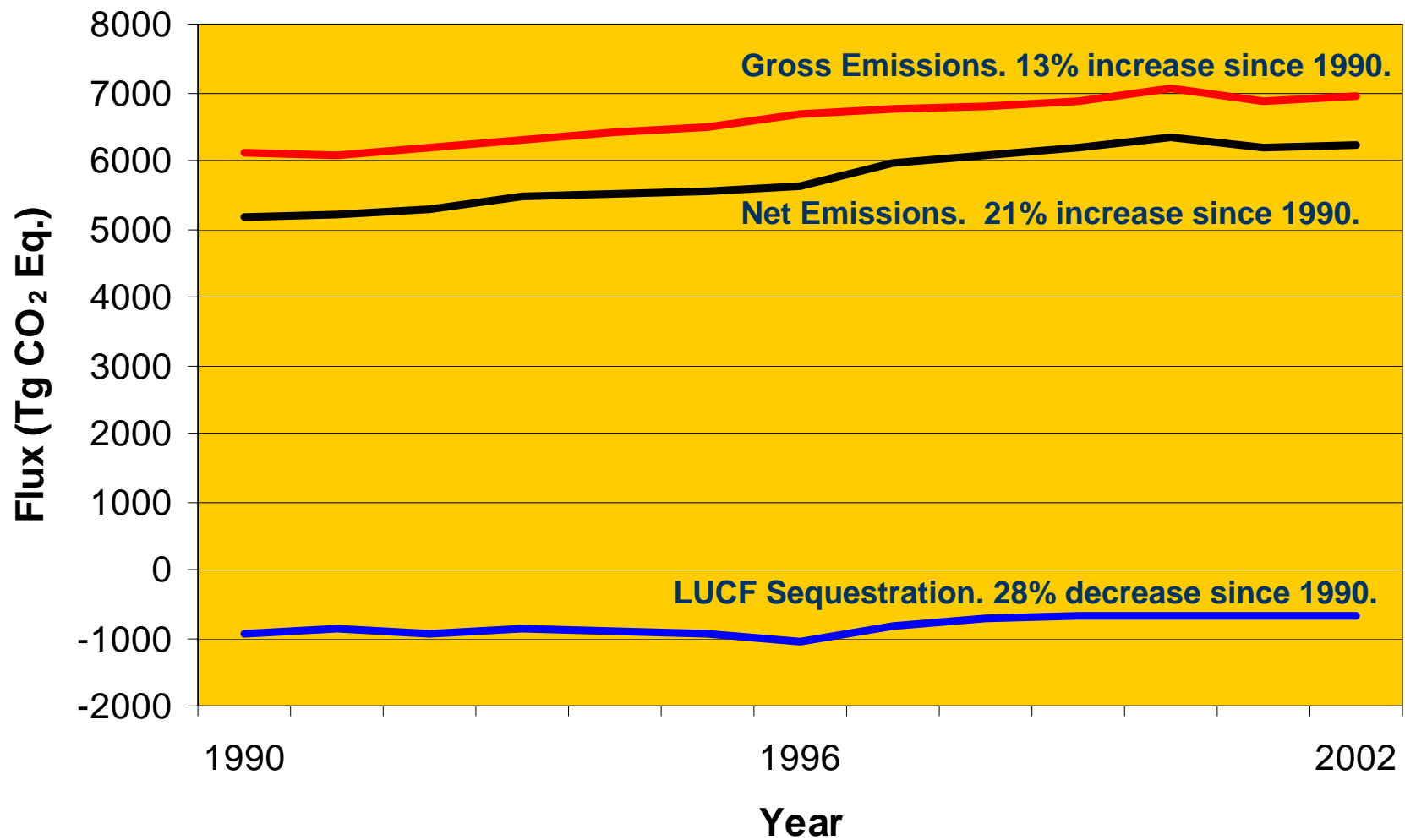
Total Gross Emissions: 6,934 Tg CO₂ Eq.

Note: Total does not sum to 100% due to independent rounding.

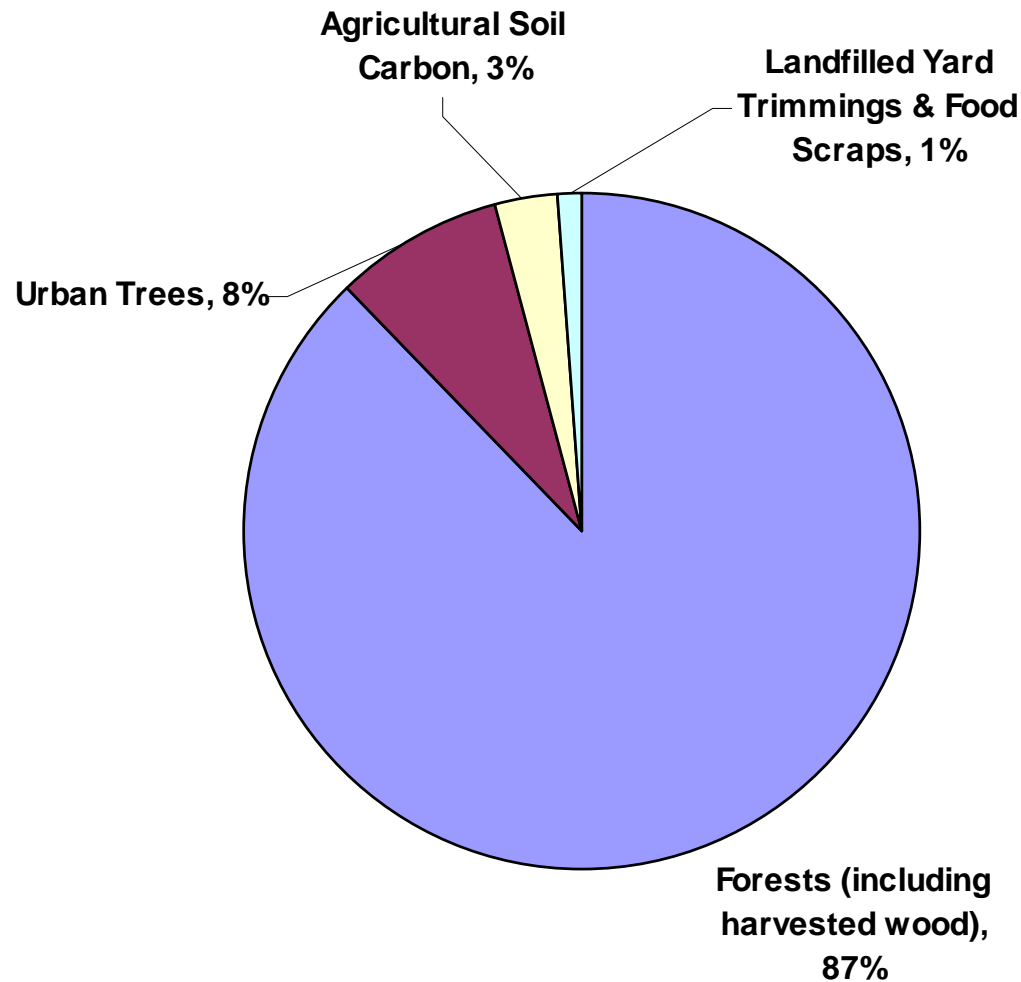
Land-Use Change and Forestry (LUCF) Sequestration in 2002



Trends



Land-Use Change and Forestry Sinks



Total Sequestration: 691 Tg CO₂ Eq.

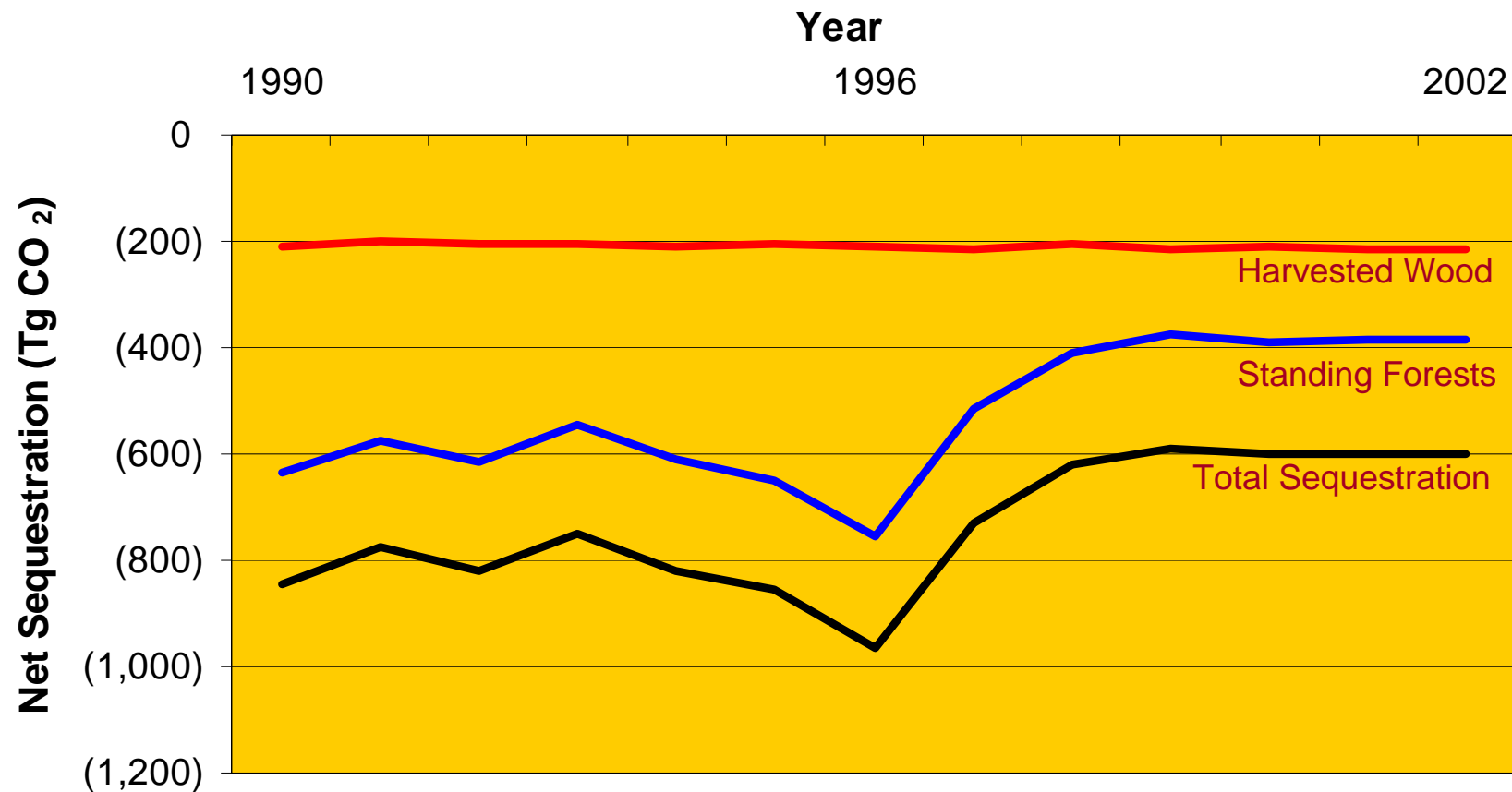
Note: Totals do not sum to 100% due to independent rounding.

Forests

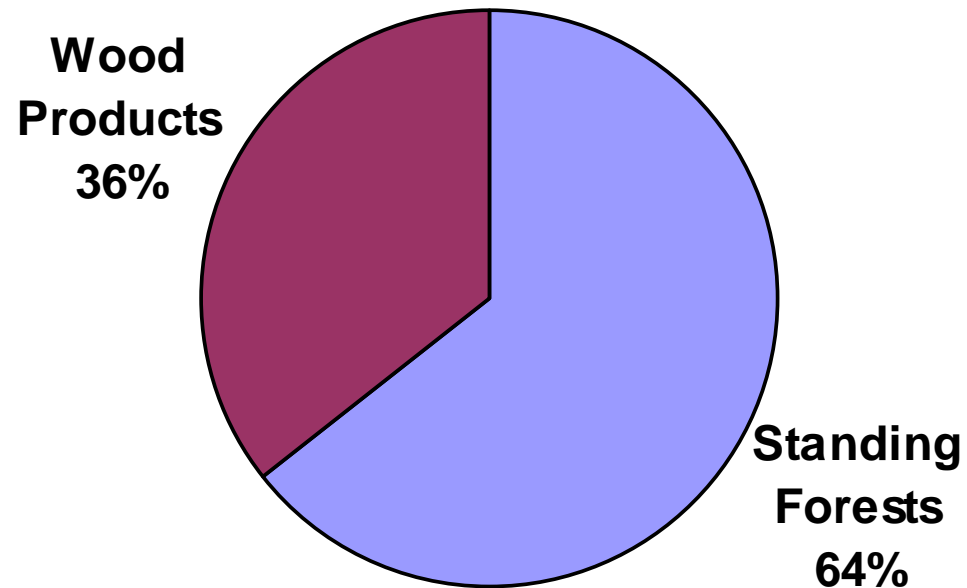


- 87% of the LUCF Flux
- 2002 Sink: 601 Tg CO₂ Eq. (0.3% of Stock)
- 2002 Stock: 54,160 Tg C (Up 5% since 1990)
- Stocks have been increasing, due to increased net forest growth & area, as well as the accumulation of C stocks in product pools
- Annual sequestration has declined 29% since 1990

Forestry Sector Trends



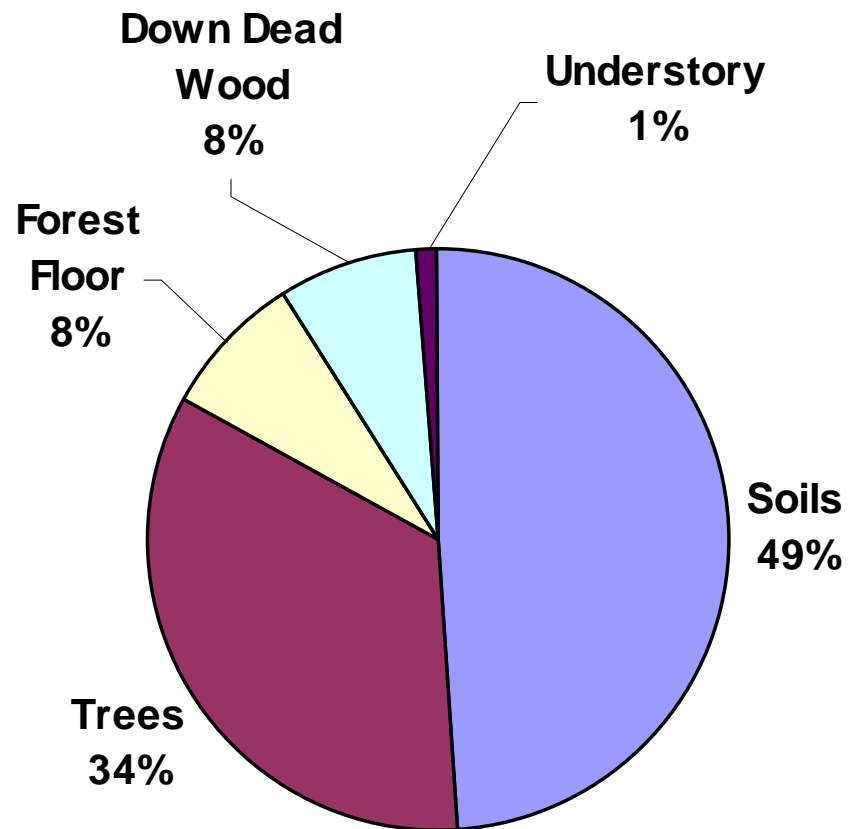
Relative Forest Flux Contributions



Total = 601 Tg CO₂ Eq.

Standing Forests

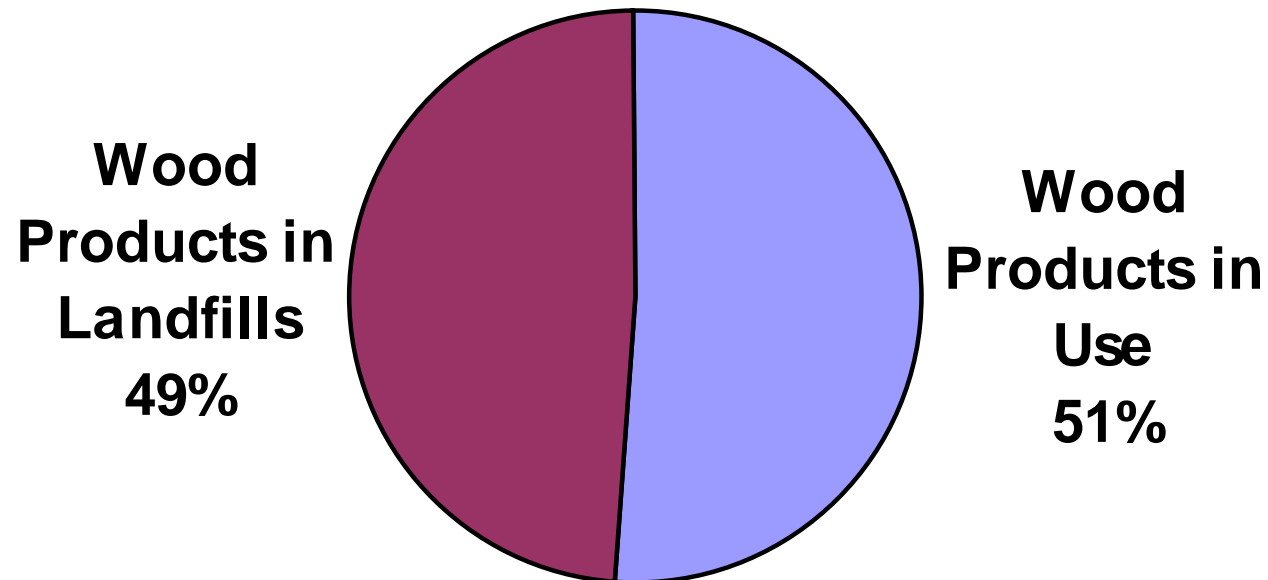
51,564 Tg C, 95% of Forest Stock



Harvested Wood



2,595 Tg C, 5% of Forest Stock



Forestry Uncertainty



- Small changes in large stocks contribute substantially to flux measurement uncertainty
- In a closely related analysis, the true flux estimate was within 15% of the reported mean (80% CI)

Planned Forestry Improvements



- Move to annualized sampling methodology that includes soil sampling and allows for less reliance on expansion factors
- Apply stock change approach to harvested wood
- Include land use conversions (especially croplands to forests)
- Evaluate N_2O from forest fertilization
- Include N_2O and CH_4 from forest fires

Urban Trees



- 8% of total LUCF Flux
- 2002 Flux: 58.7 Tg CO₂ Eq. (~0.6% of Stock)
- 2002 Stock: 2,583 Tg C
- Urban trees occur where population density is > 1000/mi² (=3.5% land area coverage)
- Urban trees have a smaller coverage than forests, but have higher C density
- Stocks appear to be decreasing with time, to be reflected in the next *Inventory*

Urban Tree Uncertainty



- Uncertainty in coverage: 5%
- Uncertainty in net sequestration: 41%
- Total Uncertainty (95% CI): 39%
Range: 36 to 82 Tg CO₂ Eq

Planned Urban Tree Improvements

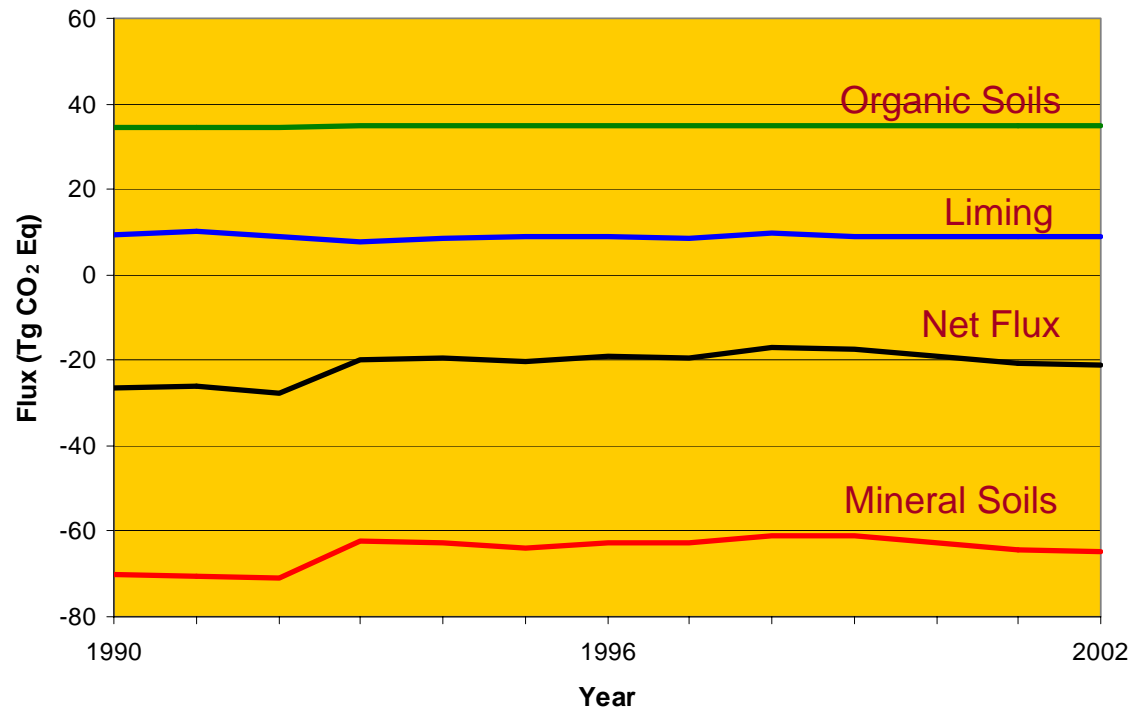


- Quantify trends in urban tree coverage through time

Agricultural Soil Carbon

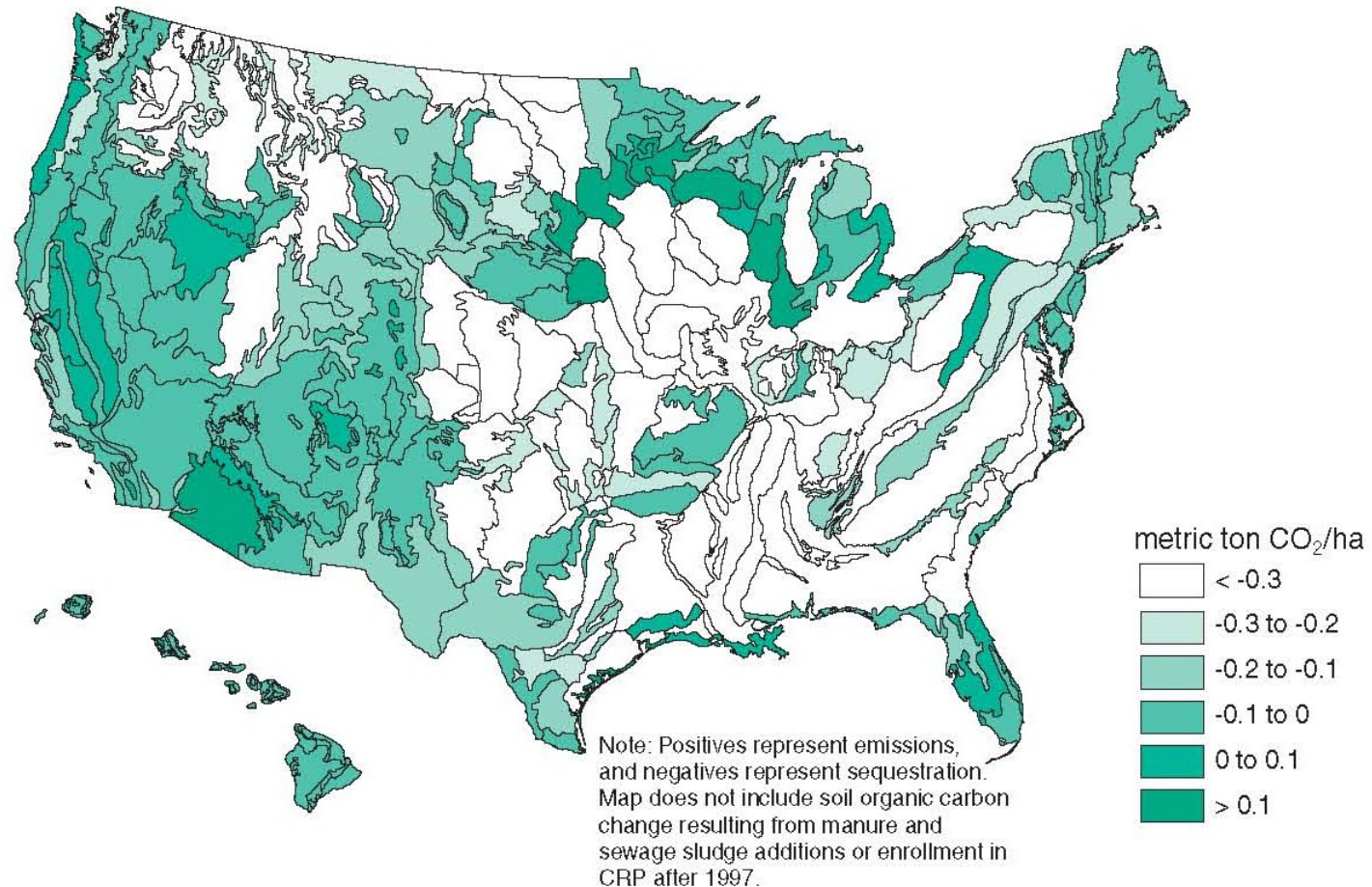


- 3% of Net LUCF Sequestration (21.2 Tg CO₂ Eq)
- Net Sequestration has declined since 1990 (~20%)



Mineral Soils (65 Tg CO₂ Eq. Sink)

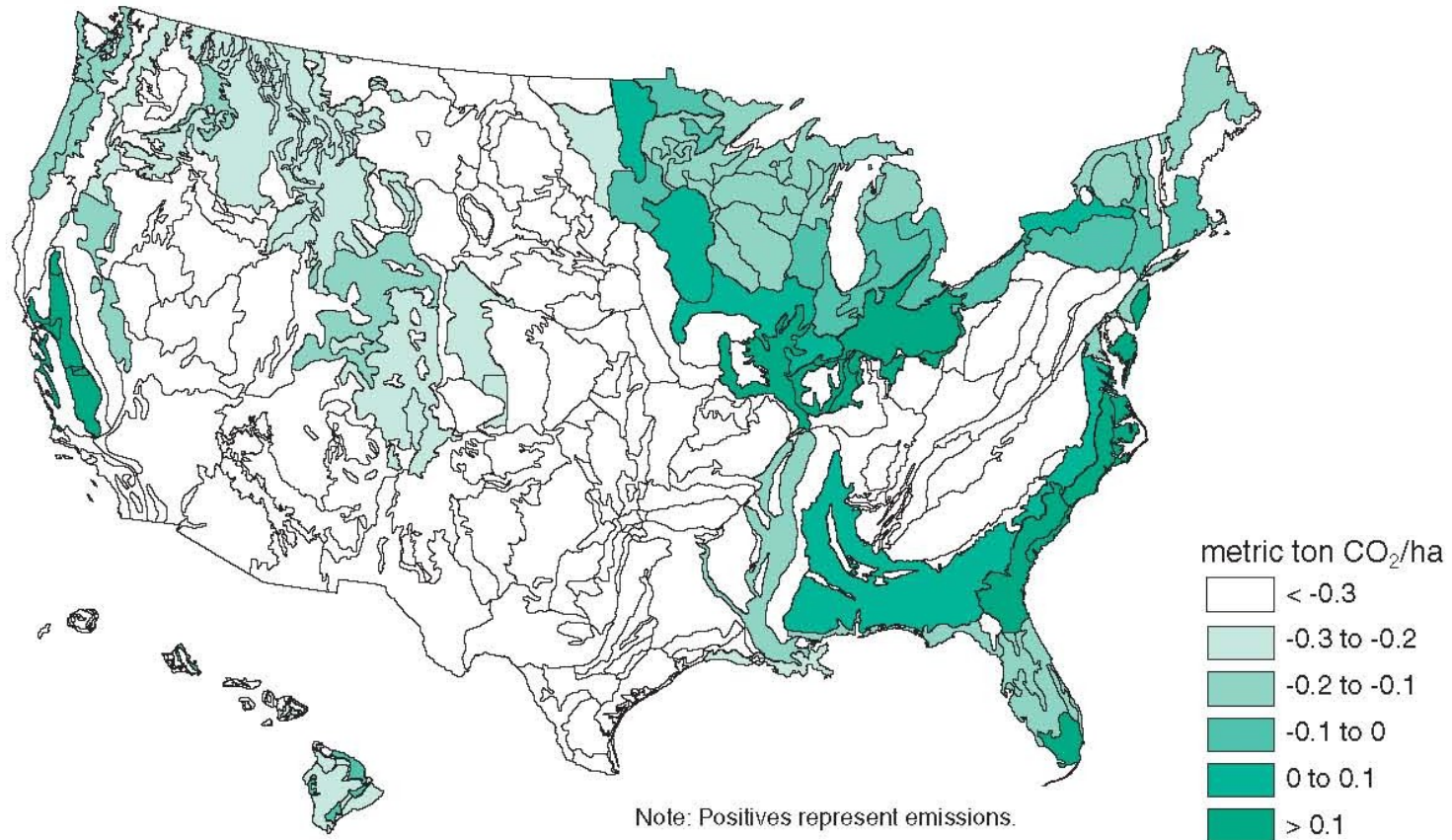
Net Annual CO₂ Flux, per Hectare, From Mineral Soils Under Agricultural Management, 1993-2002



This map shows the spatial variability in net annual carbon dioxide flux from mineral soils for the year 1993 through 2002. The color assigned to each polygon represents the average annual flux per hectare for the area of managed mineral soils in that polygon.

Organic Soils (+35 Tg CO₂ Eq. Emission)

Net Annual CO₂ Flux, per Hectare, From Organic Soils Under Agricultural Management, 1993-2002



This map shows the spatial variability in net annual carbon dioxide flux from mineral soils for the year 1993 through 2002. The color assigned to each polygon represents the average annual flux per hectare for the area of managed mineral soils in that polygon.

Soil Liming



- 9 Tg CO₂ Eq. Emission
- Down 7% since 1990

Soil C Uncertainty



Tier 2 (Monte Carlo) Method, 95% CI

Source/Sink	Average Flux Estimate (Tg CO ₂ Eq)	Uncertainty	
		Lower Bound	Upper Bound
Mineral Soils	(40.8)	(59.0) or -42%	(23.8) or 45%
Organic Soils	34.7	23.5 or -32%	49.1 or 42%
Total Soils	(6.1)	(27.9) or -359%	15.8 or 357%

Numbers in parentheses represent sequestration.

Uncertainty does not include fluxes resulting from manure or sewage sludge applications, or CRP enrollment after 1997.

Planned Soil C Improvements

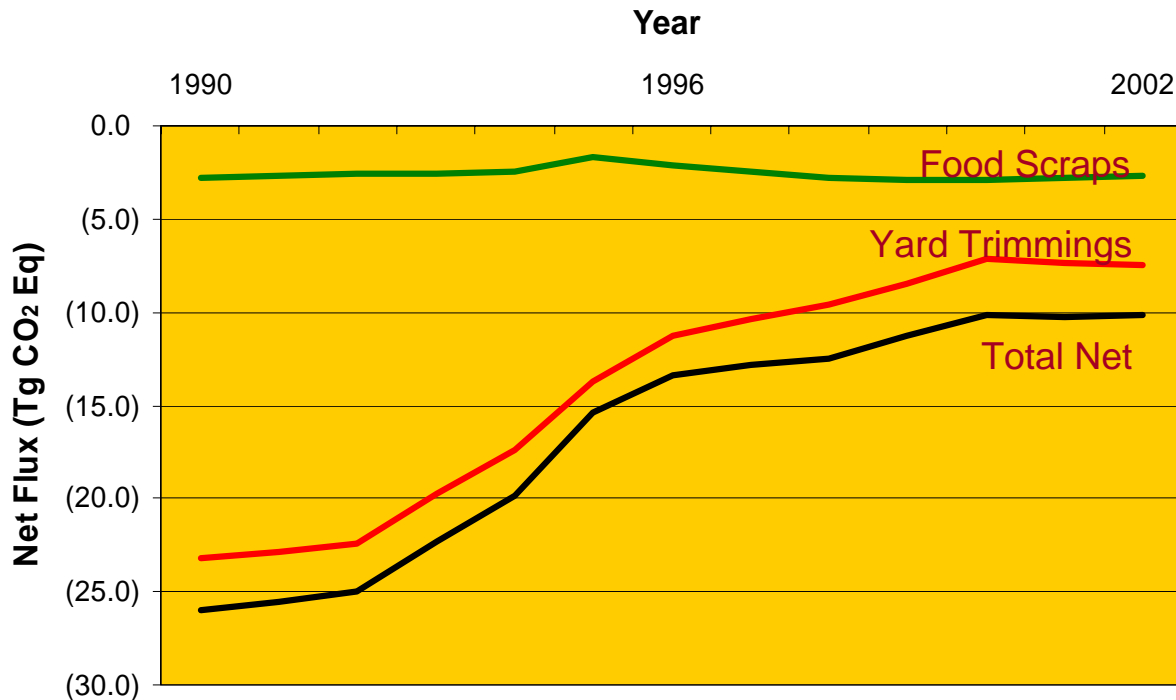


- Century ecosystem simulations will use actual climate, soil, and land use data to estimate fluxes and variability
- Uncertainty estimates for C fluxes will include manure and sludge additions, plus Conservation Reserve Program (CRP) Lands
- Land use changes involving organic soil conversions to/from non-agricultural uses will be reflected

Landfilled Yard Trimmings & Food Scraps



- 1% of LUCF Flux (10.1 Tg CO₂ Eq)
- Total Stock in 2002: 239.6 Tg C



Sequestration has decreased 61% due to reductions in YT disposal and increased composting

Landfilled YT & FS Uncertainty



- Has not yet been quantitatively calculated
- Small C storage factor dataset creates uncertainty
- Experiments have been conducive to decomposition, so sequestration may be underestimated
- Varying landfill moisture alters decomposition, but is not reflected here

Planned Landfilled YT & FS Improvements



- Improved C storage factors
- Provide consistency with the landfill methane emissions described in the Waste chapter of the *Inventory*

For more Information on Landfilled YT & FS and Wood Products:



Randy Freed, ICF Consulting
Wednesday, 2:50 p.m.

Session: Terrestrial – Sequestration in Forests

*Carbon Storage Due to Disposal of Biogenic Materials in
US Landfills*

In Conclusion



- Substantial anthropogenic terrestrial sinks exist in the US.
- Annual sequestration has decreased by 28% since 1990. Gross US GHG emissions have increased by 13%, but net emissions have increased by 21%.
- The US GHG Inventory continues to drive the state-of-the-art in innovative methods to quantify sinks. These methods have undergone multiple rounds of critical review, both domestically and internationally.
- For more info: mwalsh@icfconsulting.com